

and partially cured or B-staged at a temperature of 150° C. for the 0.25 to 5 minutes as indicated in Table 1. The foil with the B-staged inventive adhesive composition applied thereto is then laminated to a paper phenolic substrate at a lamination temperature of 150° C. and pressure of 1000 psig for 82 minutes. The resulting laminates are tested for adhesion using the peel strength test (2.4.8 of IPC-TM-650) and heat resistance using the solder blister test (JIS C 6481 5.5). The results are indicated in Table I. Example 6 in Table I is a control wherein no adhesive is used.

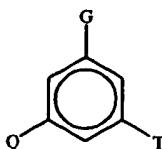
TABLE I

Ex-ample	Formulation	B-Stage Minutes	Peel Strength (Pounds/Inch)	Second Blister (Seconds)
1	75% Adduct (B-I)	2	9.67	30
	25% Rutaphen IV 2441	4	9.52	21
2	50% Adduct (B-I)	2	6.08	27
	50% Rutaphen IV 2441	4	5.78	12
3	75% Adduct (B-II)	0.25	7.63	22
	25% Rutaphen IV 2441	1.5	7.72	20
4	75% Adduct (B-II)	0.5	10.71	21
	25% 536-ME	2	10.29	16
5	70% Adduct (B-II)	0.5	9.56	20
	15% Rutaphen IV 2441	1	9.75	19
	15% 986-Z1	2	9.52	24
		3	9.72	20
6	No adhesive		5.84	19

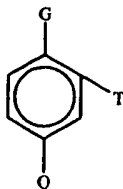
While the invention has been explained in relation to its preferred embodiments, it is to be understood that various modifications thereof will become apparent to those skilled in the art upon reading the specification. Therefore, it is to be understood that the invention disclosed herein is intended to cover such modifications as fall within the scope of the appended claims.

What is claimed is:

1. An adhesive composition, comprising:
 - (A) at least one phenolic resole resin; and
 - (B) the product made by reacting
 - (B-1) at least one difunctional epoxy resin, with
 - (B-2) at least one compound represented by the formulae



or



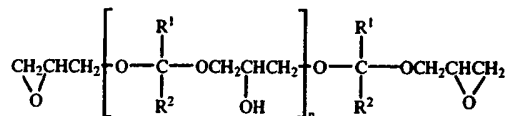
wherein in Formulae (I) and (II):

G, T and Q are each independently functional groups selected from the group consisting of COOH, OH, SH, NH₂, NHR¹, (NHC(=NH))_mNH₂, R²COOH, R²OH, NR¹₂, C(O)NHR¹, R²NR¹₂, R²SH, R²NH₂, and R²NHR¹, wherein R¹ is a hydrocarbon group, R² is an alkylene or alkylidene group and m is a number in the range of 1 to about 4; T can also be R¹, OR¹ or SO₂C₆H₄NH₂; and Q can also be H.

2. The composition of claim 1 wherein (A) has a gel time of about 30 to about 180 seconds at 150° C.

3. The composition of claim 1 wherein (A) has a solids content of about 50% to about 70% by weight prior to being combined with (B).

4. The composition of claim 1 wherein said difunctional epoxy resin (B-1) is a compound represented by the formula

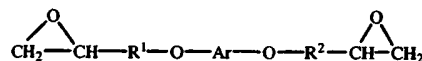


wherein in Formula (II), R¹ and R² are independently hydrogen or hydrocarbon groups in the range of 1 to about 20 carbon atoms, and n is a number in the range of 1 to about 20.

5. The composition of claim 1 wherein said difunctional epoxy resin (B-1) is a bisphenol A, bisphenol F or bisphenol AD.

6. The composition of claim 1 wherein said compound (B-2) is a compound selected from the group consisting of m-aminophenol, m-phenylene diamine, 1,3-xylylenediamine, 1,3,5-trihydroxy benzene, resorcinol, 3-anisidine, 3-toluidine, bis(3-aminophenyl)sulfone, and mixtures of two or more thereof.

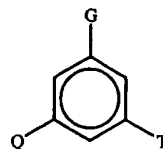
7. The composition of claim 1 further comprising at least one low molecular weight difunctional epoxy represented by the formula



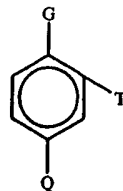
wherein in Formula (III), Ar is an aromatic or cycloaliphatic group, and R¹ and R² are independently alkylene or alkylidene groups of 1 to about 6 carbons.

8. A copper foil with an adhesion-promoting layer overlying at least one side of said foil, said adhesion-promoting layer, comprising:

- (A) at least one phenolic resole resin; and
- (B) the product made by reacting
 - (B-1) at least one difunctional epoxy resin, with
 - (B-2) at least one compound represented by the formulae



or



wherein in Formulae (I) and (II):

G, T and Q are each independently functional groups selected from the group consisting of COOH, OH, SH,

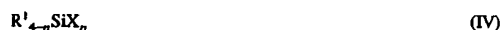
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NH_2 , NHR^1 , $(\text{NHC}(=\text{NH}))_m\text{NH}_2$, R^2COOH , R^2OH , NR^1_2 , $\text{C}(\text{O})\text{NHR}^1$, R^2NR^1_2 , R^2SH , R^2NH_2 and R^2NHR^1 , wherein R^1 is a hydrocarbon group, R^2 is an alkylene or alkylidene group and m is a number in the range of 1 to about 4; T can also be R^1 , OR^1 or $\text{SO}_2\text{C}_6\text{H}_4\text{NH}_2$; and Q can also be H .

9. The foil of claim 8 wherein said foil is an electrodeposited copper foil.

10. The foil of claim 8 wherein said foil is a wrought copper foil.

11. The foil of claim 8 with at least one silane coupling agent disposed between said one side of said foil and said adhesion-promoting layer, said silane coupling agent being at least one compound represented by the formula



wherein in Formula (IV), R^1 is a functionally substituted hydrocarbon group, the functional substituent of said functionally substituted hydrocarbon group being amino, hydroxy, halo, mercapto, alkoxy, acyl, or epoxy; X is a hydrolyzable group; and n is 1, 2 or 3.

12. The foil of claim 8 wherein at least one roughened layer of copper or copper oxide is positioned between said one side of said foil and said adhesion promoting layer.

13. The foil of claim 8 wherein at least one metallic layer is positioned between said one side of said foil and said adhesion promoting layer, the metal in said metallic layer being selected from the group consisting of indium, tin, nickel, cobalt, brass, bronze or a mixture of two or more thereof.

14. The foil of claim 8 wherein at least one roughened layer of copper or copper oxide is adhered to said one side of said foil, at least one metallic layer is adhered to said layer of copper or copper oxide, the metal in said metallic layer being selected from the group consisting of indium, zinc, tin, nickel, cobalt, brass, bronze, or a mixture of two or more thereof, and said adhesion promoting layer is adhered to said metallic layer.

15. The foil of claim 8 wherein at least one metallic layer is positioned between said one side of said foil and said adhesion promoting layer, the metal in said metallic layer being selected from the group consisting of tin, chromium, chromium-zinc mixture, nickel, molybdenum, aluminum, and mixtures of two or more thereof, and said adhesion promoting layer is adhered to said metallic layer.

16. The foil of claim 8 wherein at least one roughened layer of copper or copper oxide is adhered to said one side of said foil, at least one metallic layer is adhered to said layer of copper or copper oxide, the metal in said metallic layer being selected from the group consisting of tin, chromium, and chromium-zinc alloy, zinc, nickel, molybdenum, aluminum, and mixtures of two or more thereof, at least one layer of at least one silane coupling agent is adhered to said metallic layer, and said adhesion promoting layer is adhered to said silane coupling agent layer.

17. The foil of claim 8 wherein at least one first metallic layer is adhered to said one side of said foil, the metal in said first metallic layer being selected from the group consisting of indium, tin, nickel, cobalt, brass and bronze, at least one second metallic layer adhered to said first metallic layer, the metal in said second metallic layer being selected from the

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group consisting of tin, chromium, chromium-zinc mixture, zinc, nickel, molybdenum, aluminum, and mixtures of two or more thereof, at least one layer of at least one silane coupling agent is adhered to said second metallic layer, and said adhesion promoting layer is adhered to said silane coupling agent layer.

18. The foil of claim 8 wherein at least one roughened layer of copper or copper oxide is adhered to said one side of said foil, at least one first metallic layer is adhered to said roughened layer, the metal in said first metallic layer being selected from the group consisting of indium, zinc, tin, nickel, cobalt, copper-zinc alloy and copper-tin alloy, at least one second metallic layer is adhered to said first metallic layer, the metal in said second metallic layer being selected from the group consisting of tin, chromium, chromium-zinc alloy, zinc, nickel, molybdenum, aluminum, and mixtures of two or more thereof, at least one layer of at least one silane coupling agent is adhered to said second metallic layer, and said adhesion promoting layer is adhered to said silane coupling agent layer.

19. A laminate comprising copper foil, a dielectric substrate, and an adhesion-promoting layer disposed between and adhered to said foil and said substrate, said adhesion promoting layer comprising:

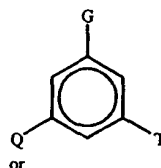
(A) at least one phenolic resole resin; and

(B) the product made by reacting

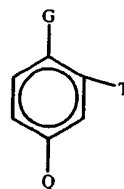
(B-1) at least one difunctional epoxy resin, with

(B-2) at least one compound represented by the formulae

(I)



(II)



wherein in Formulae (I) and (II):

G , T and Q are each independently functional groups selected from the group consisting of COOH , OH , SH , NH_2 , NHR^1 , $(\text{NHC}(=\text{NH}))_m\text{NH}_2$, R^2COOH , R^2OH , NR^1_2 , $\text{C}(\text{O})\text{NHR}^1$, R^2NR^1_2 , R^2SH , R^2NH_2 and R^2NHR^1 , wherein R^1 is a hydrocarbon group, R^2 is an alkylene or alkylidene group and m is a number in the range of 1 to about 4; T can also be R^1 , OR^1 or $\text{SO}_2\text{C}_6\text{H}_4\text{NH}_2$; and Q can also be H .

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